Improving Collaboration between Researchers and Practitioners in Construction Research Projects using Action Research Technique

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Action research is an established qualitative research method in use for scholarly investigations in information systems, business management, and human, behavioral and medical sciences. Action research aims at building and testing theory within the context of solving an immediate practical problem in a real setting. However in construction this research approach is relatively new and not many investigators, especially in the United States of America (USA) are familiar with it. In this paper, the potential applicability of the Action research technique in construction has been investigated via a case study. The paper first presents a summary of this research method, highlighting its advantages and disadvantages, with the help of two interdisciplinary research projects. Then a case study of an Executive Information System (EIS) development and implementation in a construction owner organization using Action research technique has been discussed. The results of the case study indicate that the Action research technique has a significant potential to conduct research on real-life construction industry problems. It can also effectively help to improve the collaboration between the academic researchers and the construction industry practitioners.

Keywords: Action Research, Collaborative Learning, Construction Research Methods, Information Systems Implementation, Executive Information Systems

Introduction

Traditionally, it is found that the academic researchers and the construction industry practitioners do not collaborate closely in most construction research projects. There is a perception among the construction practitioners that the academic research is more focused on subjects and issues which are not crucial for the construction industry. The practitioners also claim that the academic research results are sometimes inapplicable and impractical for use in real-life construction projects. The researchers on the other hand argue that the construction industry practitioners often do not entertain innovative research ideas which require a major change in the industry practices and procedures. This situation dictates the need to enhance the researcher-practitioner collaboration to conduct research on problems which are vital for the construction industry and to find out their adoptable solutions.

Construction is an industry bound by traditions, not necessarily by choice, but because of the ways organizations is setup, and have worked over the years, and because of their dependence on age-old norms and rules. Implementation of new research concepts is always challenging in construction, as it would have an impact on these set-ups, norms and rules. A close collaboration of researchers and construction industry practitioners can ensure that the research results would be acceptable and applicable in the construction organizations (Ahmad and Azhar, 2004).

A novel approach to improve the collaboration between researchers and practitioners is provided by the Action research technique. This qualitative research method is unique in the way it associates research and practice through change and reflection (Rezgui, 2006). Action research aims at building/testing theory within context of solving an immediate practical problem in a real setting. It combines theory and practice, researchers and practitioners, and intervention and reflection. The method produces highly reliable research results, because it is grounded in practical action, aimed at solving a realistic problem situation while carefully informing theory (Baskerville, 1999).

Action research is also known as a Problem-solving approach. In Action research, the researcher reviews the existing situation, identifies the problem(s), gets involved in introducing some changes to improve the situation and, evaluates the effect of those changes. This type of research is more attractive to researchers, practitioners and students from the professional background who have identified a problem during the course of their work and wish to investigate and propose a change to improve the situation (Naoum, 2001). Action research is an established research method in use for scholarly investigations in the fields of information systems, business management, and social and medical sciences. However in construction this research approach is relatively new and unknown to most people in the USA.

In this paper, the potential applicability of the Action research philosophy in construction has been investigated. For readers who are not familiar with Action research, a summary of this research technique with its advantages and disadvantages is outlined. It is followed by brief discussion on two multidisciplinary research projects which were executed using the Action research technique. Then to demonstrate its use in construction, a case study of an Executive Information System (EIS) implementation in a construction owner organization has been presented. At the end, discussion is made on a construction research program started at the Loughborough University, UK which is based on the principles of Action research. It is desired that the paper will be useful for construction researchers and practitioners who are seeking to improve collaborative efforts in industry-based research projects.

The Action Research Approach

Action research is an iterative technique in which the researcher investigates the problem domain, diagnoses the problem, gets involved in introducing some changes to improve the situation and evaluates the effects of those changes (Naoum, 2001). Hult and Lennung (1980) have defined the following three characteristics of Action research which distinguishes it from other research methods:

(1) Action research aims at an increased understanding of an immediate problem situation, with emphasis on the complex and multivariate nature of organizations.
(2) Action research simultaneously assists in practical problem solving and expands scientific knowledge. This goal extends into two important process characteristics: First, there are highly interpretive assumptions being made about the observation; second, the researcher intervenes in the problem setting.

(3) Action research is performed collaboratively and enhances the competencies of both researchers and practitioners. It links theory and practice to generate a solution.

Steps in Action Research Approach

Action research is a five phase cyclical process. The approach first requires the establishment of a client-system infrastructure or research environment (Susman and Evered, 1978). The client-system infrastructure is the specifications and agreement that constitutes the research environment. It provides the protocol under which the researchers and practitioners would conduct the research work (Clark, 1972). Then, five identifiable phases are iterated which are depicted in Figure 1.

1. Diagnosing

Diagnosing corresponds to the identification of the primary research problem(s). Diagnosing involves self-interpretation of the complex research problem, not through reduction and simplification, but rather in a holistic fashion. The diagnosis leads to develop certain theoretical assumptions (i.e., a working hypothesis) about the nature of the problem domain (Baskerville, 1999).

2. Action Planning

Researchers and practitioners then collaborate in the next activity, *action planning*. This activity specifies organizational actions that should relieve or improve the primary problem(s). The discovery of the planned actions is guided by the theoretical framework, which indicates both desired future state and the changes that would achieve such a state (Baskerville, 1999).

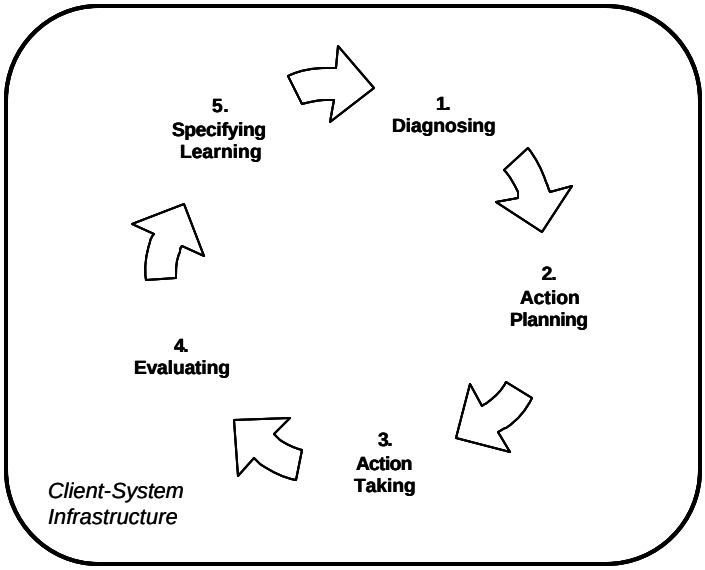

Figure 1: The Action Research Cycle (Adapted from Baskerville, 1999)

3. Action Taking

Action taking implements the planned action(s). The researchers and practitioners collaboratively intervene into the client (practitioner's) organization, causing certain changes to be made. Several forms of intervention strategy can be adopted. For example, the intervention might be *directive*, in which the research "directs" the change, or *non-directive*, in which the change is sought indirectly. The process can draw its steps from social psychology, e.g., engagement, unfreezing, learning and re-framing (Baskerville, 1999).

4. Evaluating

After the actions are completed, the collaborative researchers and practitioners evaluate the outcomes. Evaluation includes determining whether the theoretical effects of the action were realized, and whether these effects relieved the problems. Where the change was successful, the evaluation must critically question whether the action undertaken was the sole cause of success. Where the change was unsuccessful, some framework for the next iteration of the Action research cycle (including adjusting the hypotheses) should be established (Baskerville, 1999).

5. Specifying Learning

While the activity of specifying learning is formally undertaken last, it is usually an ongoing process. The knowledge gained in the Action research (whether the action was successful or unsuccessful) can be directed to three audiences (Baskerville, 1999):

(1) The restructuring of organizational norms to reflect the new knowledge gained by the organization during the research.
(2) Where the change was unsuccessful, the additional knowledge may provide foundations for diagnosing in preparation for further Action research interventions.
(3) The success or failure of the theoretical framework provides important knowledge to the scientific community for dealing with future research settings.

The Action research cycle can continue, whether the action proved successful or not, to develop further knowledge about the organization and the validity of relevant theoretical frameworks. As a result of the studies, the organization thus learns more about its nature and environment, and the constellation of theoretical elements of the scientific community continues to benefit and evolve (Argyris and Schön, 1978).

Strengths and Weaknesses of Action Research

Action research has both strengths and weaknesses. First, a strength of the method is that it provides a rich explanation of "how" and "why" phenomena (problem under investigation) occur – which sometimes cannot be explained through statistical or regression models. Second, research problem(s) are studied in a natural setting which would be expensive, difficult, and/or impossible to replicate in a laboratory experiment. A weakness is that it fundamentally assumes that an espoused theory should adequately specify action, which is rarely the case. A second weakness is that the conclusions from a single study may have limited generalizability (Hales

and Chakravorty, 2005). Stake (2000) mentioned that such real world studies are still valuable for refining theory and suggesting directions for further investigations.

Distinguishing Action Research from Consulting

Action research processes and typical organizational consulting processes contain substantial similarities. However Action research and consulting differ in five key ways (Kubr, 1986; Lippitt and Lippit, 1978):

(1) *Motivation:* Action research is motivated by its scientific prospects, perhaps epitomized in scientific publications. Consulting is motivated by commercial benefits, including profits and additional stocks of proprietary knowledge about solutions to organizational problems.
(2) *Commitment:* Action research makes a commitment to the research community for the production of scientific knowledge, as well as to the client. In a consulting situation, the commitment is to the client alone.
(3) *Approach:* Collaboration is essential in Action research because of its idiographic assumptions. Consulting typically values its "outsider's" unbiased viewpoint, providing an objective perspective on the organizational problems.
(4) *Foundation for recommendations:* In Action research, this foundation is a theoretical framework. Consultants are expected to suggest solutions that, in their experience, proved successful in similar situations.
(5) *Essence of the organizational understanding:* In Action research, organizational understanding is founded on practical success from iterative experimental changes in the organization. Typical consultation teams develop an understanding through their independent critical analysis of the problem situation.

In summary, consultants are usually paid to dictate experienced, reliable solutions based on their independent review. Action researchers act out of scientific interest to help the organization itself to learn by formulating a series of experimental solutions based on an evolving, untested theory (Baskerville, 1997).

Use of Action Research in Multidisciplinary Investigations

The holistic nature of Action research approach makes it an ideal candidate for multidisciplinary investigations involving technological, human and organizational aspects. For example, to study the impact of information systems implementation on the organizational structure of a company or to investigate the effects of business processes reengineering on organizational or employee's productivity. In the following paragraphs, a brief discussion is made on two multidisciplinary research projects where Action research technique was used.

Project 1: Exploring Virtual Team-Working Effectiveness in Construction

In this project, the effectiveness of virtual teams in the construction sector was investigated using the Action research technique. The project was carried out at the University of Salford, UK

(Rezgui, 2006). The research scope required to: (1) understand the current ICT-related (Information and Communication Technology) practices used in construction organizations and to capture their strengths and limitations; (2) specify the technological and organizational environment supporting the virtual collaboration of teams on construction projects; and (3) validate the findings through a proof of concept demonstrator system deployed in real organizational contexts. The research objectives and scope indicated the need to study the technological, social and organizational aspects of virtual teams in a real setting, hence the Action research technique was considered as the best-suited research method. Two small and medium size enterprises were selected as industry-partners to carry out the research. Three iterations of Action research cycle were conducted over a period of 27 months to find out an optimum solution. The research results identified important socio-organizational issues related to technology adoption, team identification, trust and motivation which are critical for the success of virtual teams. The end product of the research is a framework which could help with the formation of virtual teams for different types of construction projects under different organizational and social settings.

Project 2: Improving Quality Management in an Industrial Organization

This project demonstrates the use of Action research in implementing Deming's style of quality management in an industrial organization (Hales and Chakravorty, 2006). The Deming's approach to quality management is well known. Almost all introductory textbooks on quality management have a detailed discussion on Deming and his philosophy of quality management (Goetsch and Davis, 2003). Past researchers indicated a possible gap between theory and practice of Deming's style of quality management. In this context, this research was conducted to describe how Deming's style of quality management can be actually implemented in an industrial organization. The industry partner was a plastics company. The researchers formed a focus (or representative) group within the company comprising of top, middle and lower management to classify problems and to develop potential solutions. The focus group involved all plant employees in the improvement process by listening to their concerns at every stage of quality management process. Several iterations of the Action research cycle were conducted before formalizing a formal quality management framework which was successfully implemented in the organization.

Use of Action Research Technique in Construction: A Case Study

This section demonstrates the use of Action research technique in construction through a case study of an Executive Information System (EIS) implementation in a construction owner organization. An EIS provides a wide range of summarized and integrated information to the senior management for planning and decision-making. In accordance with the Action research methodology, the various stages of the research are discussed in the following sections.

Research Problem

Construction organizations typically deal with large volumes of project data containing valuable information. It is found that these organizations do not use construction data effectively for

planning and decision-making. There are two reasons. First, the information systems in construction organizations are designed to support day-to-day construction operations. The data stored in these systems are often non-validated, non-integrated and are available in a format that makes it difficult for decision makers to use in order to make timely decisions. Second, the organizational structure and the IT infrastructure are often not compatible with the information systems thereby resulting in higher operational costs and lower productivity. These two issues had been investigated in this research.

Justification for Use of Action Research Technique

The Action research approach was adopted to conduct this research due to three reasons:

(1) The research portrayed a real problem situation (i.e. ineffective utilization of project data in planning and decision-making) which was identified in the construction industry through exploratory studies.
(2) The research dictated the need of very close researcher-practitioner collaboration to find an adoptable solution which should satisfy the needs of the construction industry.
(3) The research domain includes construction processes, information systems and organizational setup. Due to the different functionalities and behaviors of these domains, the effectiveness of a solution can only be judged by its application and evaluation within an actual organization. The Action research framework provides this functionality.

Discussion on Research Design and Results

Inline with the Action research technique, the research was conducted in five interrelated phases as shown in Figure 2. The steps taken in these phases are discussed in the following paragraphs:

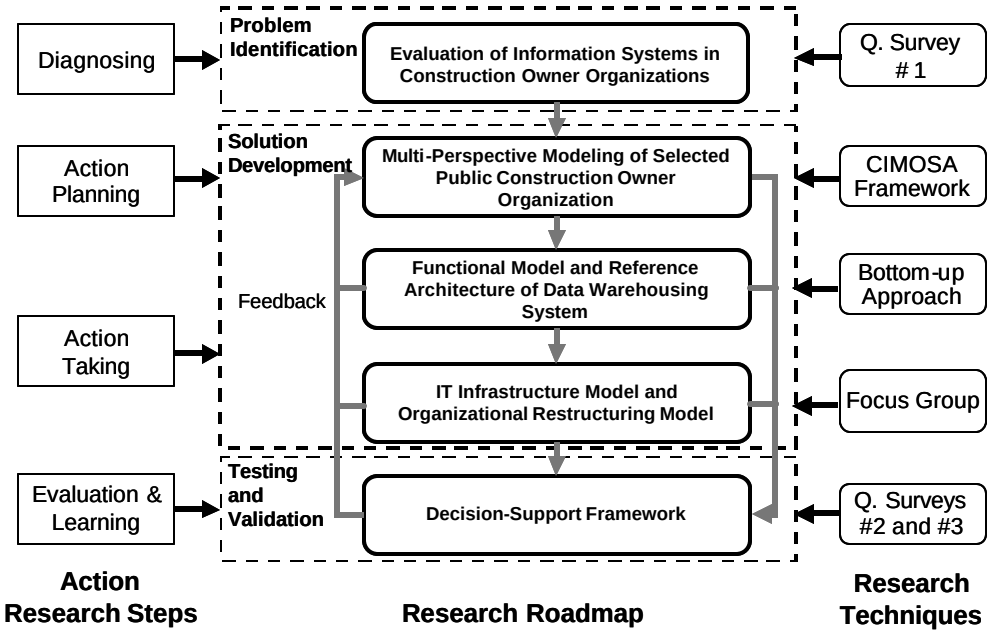

Figure 2: Research Methodology Framework

1. Problem Diagnosis

To diagnose the scope of the research problem, a questionnaire survey was conducted among the construction owner organizations (such as the Departments of Transportation, Port and Transit Authorities, Public Works Departments, Power, Oil and Gas Companies, Corporate Owners and Builders/Developers) within the United States. The details of the survey can be found in a paper by Azhar and Ahmad (2006). The purpose was to assess the degree of utilization of existing information systems (IS) in planning and decision-making. It was found that information systems in most organizations process project data to prepare summary reports for project monitoring and control. Very few organizations have information systems which can store and manage project data to carryout formal project planning and decision-making. The results of this questionnaire survey also validated the initial research hypothesis that construction owner organizations do not effectively utilize their project data for planning and decision-making due to a lack of decision-support in their existing information systems (IS).

2. Action Planning

The Action research methodology suggests that if a problem situation is present in a number of similar nature organizations then one organization may be chosen as a host for data collection, model/framework development, testing and validation. The research results then could be generalized for other organizations with suitable modifications (Reason and Bradbury, 2001).

One local public owner organization in the state of Florida, hereinafter termed as *client organization* was chosen as a collaborator for this research study. The reason for this selection was their staff's motivation concerning this research, firm commitment of executive management and grant of access to research-related data. The client organization remained involved in this research via a "Focus Group" consisting of organization's executives from different departments. A focus group may be defined as a group of individuals selected and assembled by researchers to discuss and comment on, from personal experience, the topic that is the subject of the research. Focus groups are not polls but results in in-depth qualitative interviews with a small number of carefully selected people who have full knowledge about the subject. The size of a focus group varies from six to twelve people. The focus group may work in different ways such as by conducting one or several moderated discussions of all participants, by continuously take feedback from all participants and cross-examine them, by conducting a training and discussion workshop, or by using any combination of above-mentioned schemes (Gibbs, 1997).
In this research, the focus group provided their feedback at different stages of research through questionnaire surveys, individual and group discussions and via brain-storming sessions. The following actions were planned in this stage:

a. Enterprise modeling:

The purpose of enterprise modeling was to capture the current or "AS-IS" state of the organization and model it from various perspectives such as functional, organizational, informational, decision-making etc. These models were developed to understand the organization's business operations, flow of information within, into and outside the organization,

identification of decision nodes and their hierarchy, and data requirements for these decisions. The information drawn from these models was used to recognize functional, informational and organizational requirements for the new Executive Information System (EIS).

The modified CIMOSA (Computer Integrated Manufacturing Open Systems Architecture) framework was used to model *organization, function, information,* and *decision* perspectives of the client organization. Organizational hierarchical relationships were identified using organizational charts. For function modeling, IDEF0 (Integrated Definition for Function Modeling) technique was adopted. Information modeling was performed using Object Oriented modeling concept. For decision modeling, a matrix of construction decisions and respective information needs was prepared. The purpose of this matrix was to identify various construction-related decisions taken at different management levels and information requirements for these decisions.

In the next step, the operational data and their flow patterns in the organization were investigated by preparing data and information flow models. The purpose was, (1) to identify operational data and information flow into, within and outside the organization; (2) to examine degree of information processing at different management levels; and (3) to explore various detailed, summarized and exceptional reports prepared for different management positions. In the last step, decision-support requirements matrices for various management levels were developed by mapping data and information flow models with the decision model (i.e. construction decisions versus information needs matrix). These matrices were used to compare information desired and information available at various management levels for planning and decision-making operations. They also served as the guide map to capture user requirements for preparing the EIS functional model.

It is beyond the scope of this paper to include details about the enterprise modeling. Interested readers may contact the author of this paper to get more details.

b. Development of functional model and reference architecture of the Proposed Executive Information System (EIS):

Based on the user requirements identified in the previous stage, a functional (or logical) model of the executive Information System (EIS) and its corresponding reference architecture were developed. The functional model guided the focus group how the system would work while the reference architecture indicated its physical and technical implementation using different software and hardware tools.

Instead of using traditional database management systems, the proposed EIS deployed data warehousing technology. A data warehouse is a dedicated database system created by combining data from multiple databases for purposes of analysis. A data warehouse collects all data into one system, organizes the data for consistency and easy interpretation, keeps "old" data for historical analysis, and makes access to, and use of data a simple task so that users can do it themselves without great technical proficiency in data handling. The primary purpose of a data warehouse is to provide easy access to specially arranged data that can be used with decision support

applications, such as management reporting, queries, data mining and executive information systems (Ahmad and Azhar, 2005).

c. Organizational restructuring:

During the course of this research, it was recognized that the successful implementation of the proposed EIS would require appropriate changes in the organizational structure. As a result, an organizational restructuring model was also developed. For this purpose, the impact of EIS on different divisions and management positions of the client organization was examined to determine the reduction in work load and improvements in decision-making processes. The job functions of each management position before and after the EIS implementation were discussed with the focus group to get their insight and feedback. Based on these discussions, different organizational restructuring models were prepared and theoretically tested. From this one model was approved by the focus group.

3. Action Taking

In this stage, the prototype EIS was partially implemented in the client organization. Training workshops were conducted to educate the members of the focus group about this new system. The members of the focus group tested the performance of the system and verified its accuracy. After testing the prototype system, the members of the focus group proposed that the organizational restructuring would be carried out after one year of full-scale system implementation and comprise of two phases. In the first phase some lower management positions would be eliminated which were typically involved in data analysis and reports preparation for the executives. The reason was that the EIS would perform all these tasks and hence these positions might no longer be needed. The second phase suggested the merger of two functional departments (i.e. Construction Management department and Project Control department) to form a single new department (i.e. Project Management and Control). The reason behind this decision was to bring all split functional areas under one management to save time and operational costs which were squandered in coordination and distributed decision-making. A precise cost analysis showed that the organizational redesigning would result in substantial savings in direct salary costs and indirect administrative costs.

4. Evaluating

Improvements in the organization after implementing the EIS were evaluated using various performance measures. Table 1 shows the focus group opinions before and after EIS implementation.

Table 1: Comparison in Performance before and after EIS Implementation

Comparison Criteria	Mean of Responses		Sum of Squares (X^2)	Significant error (p)
	Without EIS	With EIS		
Ease in data access	2.83	4.33	8.42	0.01
Data quality	3.12	4.67	6.97	0.03
Data integration	2.45	4.56	7.01	0.02
Organizational Productivity improvement	1.98	4.67	9.14	0.01
Quality of reports	2.78	3.67	5.12	0.03
Support for every day decisions	2.46	4.67	10.12	0.00
Support for short and long term planning	1.78	4.83	6.98	0.01

The results indicate that the significant error (p) in all cases is below 0.05 (<5%). This means that the results are statistically significant, i.e. significant improvements were recorded after the implementation of the Executive Information System (EIS). To further validate the research results, twenty public construction owner organizations who earlier took part in the problem-diagnostic survey were chosen. A demonstration is made to these companies about the possible implementation of the proposed EIS in their organizations. Their feedback was collected via a questionnaire survey which further supported the research results.

5. Specifying Learning

The learning made from this research project can be categorized into two groups:

(a) Learning for Practice:

- The project has demonstrated how to design and implement Executive Information Systems (EIS) for planning and decision-making using data warehousing, enterprise modelling and organizational restructuring in a construction owner organization.

(b) Learning for Research:

- A framework for development and implementation of EIS in construction owner organizations was developed as shown in Figure 3.
- The research increased the understanding of the interplay between technology and organization.
- The research results added knowledge to the construction management literature via scholarly publications.

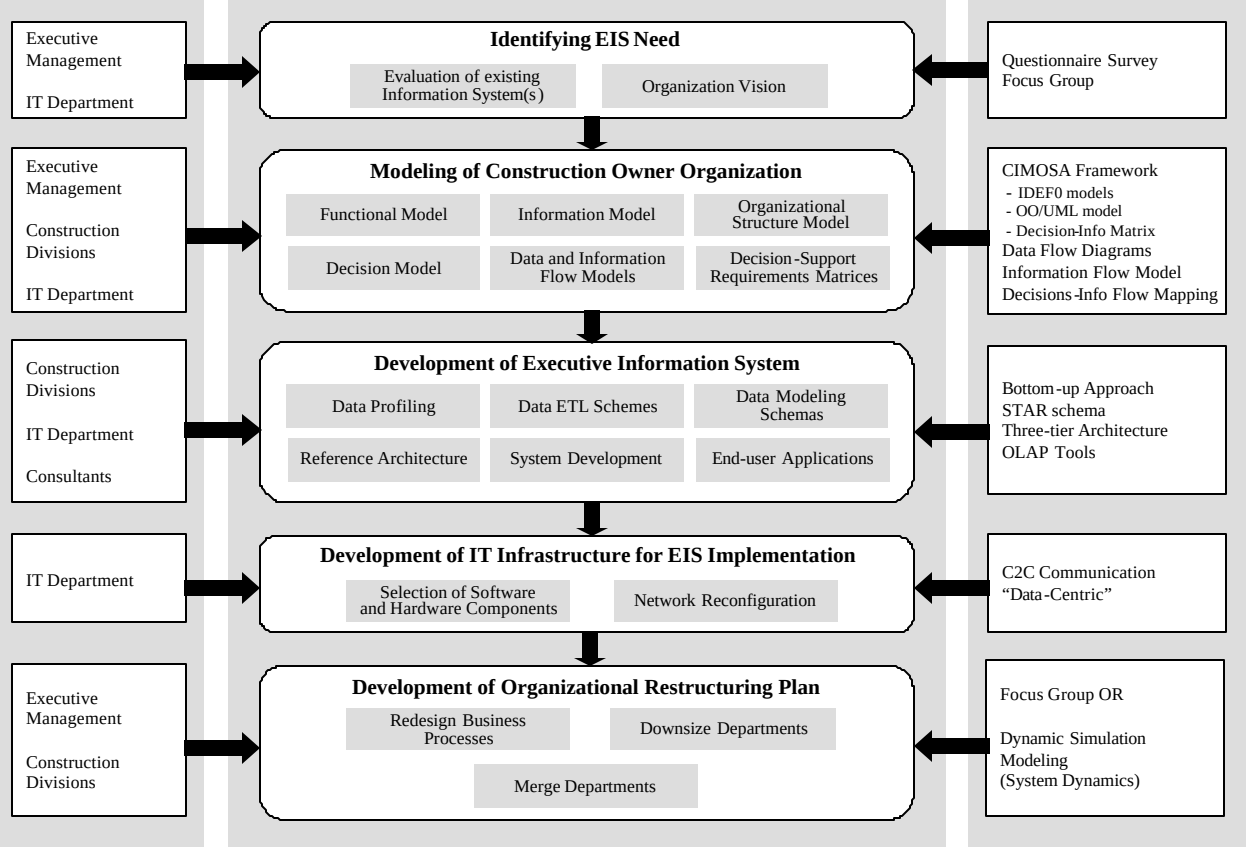

Figure 3: The Proposed Framework for Development and Implementation of EIS in Construction Owner Organizations

A Construction Research Program based on Principles of Action Research Technique

Based on the principles of Action research, the Center of Innovative and Collaborative Engineering (CICE) at the Loughborough University has started an Engineering Doctorate (EngD) program. The details of this program can be found at http://www.lboro.ac.uk/cice/. The Doctor of Engineering (EngD) is a four-year degree program. The core of the degree is the solution of one or more significant and challenging engineering/construction problems with an industrial context. Thus the solution of the problem will have to take factors such as financial constraints, timescales and personnel management into account. The EngD is a radical alternative to the traditional PhD, being better suited to the needs of the industry, and providing a more vocationally oriented doctorate in engineering. It is therefore, basically an industry-based PhD.

The program requires candidates to spend a large proportion (typically 70-80%) of their time at the premises of their collaborating company, depending on the nature of the project. Each candidate has an Academic advisor and an Industrial advisor. The Industrial advisor is from the same company where the candidate works (often the immediate supervisor of the candidate). The EngD degree is assessed by means of a mini-thesis and a portfolio of work skills developed

during the course of research and practice. So far 12 research engineers have completed their EngD and more than 25 students are currently working on their research projects. Details about their research can be found at http://www.lboro.ac.uk/cice/ research_engineers.htm.
In the United States, the author is not aware of any such industry-based graduate research program. These types of programs can play a pivotal role in bringing the academia and the construction industry closer. It may be appropriate to test the effectiveness of such a program at the Masters level. The Associated School of Construction (ASC) and different construction trade organizations such as Associated General Contractors of America (AGC) or Associated Builders and Constructors (ABC) should look into this opportunity to collaborate more effectively in the future. Such cooperation will strengthen both academia and the construction industry by producing graduate research engineers who will not only be familiar with the problems and needs of the construction industry but also have the skills to solve them.

Conclusions

The research results indicate that the Action research technique provides an effective platform to increase collaboration between the academic researchers and the construction industry practitioners to focus on the solution of real-life construction problems. Action research simultaneously assists in practical problem-solving and expands scientific knowledge, as well as enhances the competencies of the researchers and practitioners. This method is especially useful in multidisciplinary research where the investigator wants to analyze the effects of technological changes in the organizational and social context. An Action research based Doctorate of Engineering (EngD) program has been started at the Loughborough University, UK which is proven to be very successful and is receiving great attention from the construction industry. In USA, the academic, professional and construction trade organizations must brainstorm to investigate the initiation of a similar program at the graduate level. Such a step will bring academia and the industry closer and result in more industry-focused research projects.

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